Fermilab

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Mechanical Support Engineering Note

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Project: JGG Coil Replacement

Project Internal Reference:

Title: Design of the Beams used to move the coils

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Key Words:

Abstract/Summary:

This note details the design of the beams used to raise and lower the coils in the JGG for installing the new aluminum coils.

Applicable Codes:

AISC Manual of Steel Construction, Ninth Edition.

Changing the JGG Coils
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This job involves the removal of the old copper coils for the Jolly Green Giant magnet and replacing them with the new aluminum coils. To do this without taking the entire yoke apart we have decided to use two I beams on top of the yoke as the frame for handling the coils. There will also be two identical beams under the top coils to support them as they are lowered. The procedure will then be as follows:

1. Raise/lower the old coil section using the Ibeams and chain falls to rollers.
2. The rollers are in guide channels acting as tracks.
3. Move the coil pieces to the north on the tracks.
4. Remove the coils out the west rollup door using a forklift with 9 foot forks.
5. Continue until all of the old coil sections are out.
6. Reverse the process to install the new aluminum coils.

The old coils are copper and estimated at 7500 pounds each while the new aluminum coils are estimated at 3557 pounds each. Use the heavier weight for all of the calculations. The proposed beams are W8 X24 steel I beams. Note that there are two copper coils in the same volume as one aluminum coil The beams have to support two copper coils or 15,000 lbs.

Properties of the beam

$S_{xx} := 20.9 \cdot in^3 \quad \checkmark \qquad A := 7.08 \cdot in^2 \quad \checkmark$

To find the stresses is the beam choose case 4 of the AISC code, page 2-297. For this case the following applies:

$a := 11.5 \cdot in \qquad b := 87 \cdot in \qquad c := 11.5 \cdot in \qquad w := \frac{15000 \cdot lb}{87 \cdot in} = 172.4\ \#/in$

$l := a + b + c = 110\ in$

$R_1 := \frac{w \cdot b}{2 \cdot l} \cdot (2 \cdot c + b) = 7500\ \#$

$M_{max} := R_1 \cdot \left(a + \frac{R_1}{2 \cdot w} \right)$

$M_{max} = 2.494 \times 10^5\ lb \cdot in \quad \checkmark$

Now find the stress in the beam:

$\sigma_{bend} := \frac{M_{max}}{S_{xx}} = 11,933\ psi$

$\sigma_{bend} = 1.193 \times 10^{4} \frac{lb}{in^2}$ ✓

This stress is OK in bending. An A-36 beam would be allowed by the AISC to have a maximum bending stress of 23.8 Ksi which is greater than 12 Ksi.

To carry the loads we will be using four 2 ton chain falls attached to the beam with shackles. From the Crosby catalogue a 2 ton shackle has a pin diameter of 1/2 inch. For clearance use a 9/16 inch hole. The flange will be cut back from the hole at the end to allow room for the shackle.

Look at tearing of the beam metal by the pin.

$F_{shear} := 0.40 \cdot 36000 \cdot \frac{lb}{in^2}$ ✓ Shear stress limit from AISC

$P_{shear} := 4000 \cdot lb$ ✓ Shear load on the shackle

$A_{req} := \frac{P_{shear}}{F_{shear}}$ ✓

$A_{req} = 0.278\, in^2$ ✓ Minimum Area of shear required for the tearout strength

$t_{web} := .25 \cdot in$ ✓

$Holedis := \frac{A_{req}}{2 \cdot t_{web}}$ Area of shear is twice the distance from beam edge to hole center

$Holedis = 0.556\, in$ ✓ This is the minimum distance the hole can be from the edge.
We will use 3/4" for the distance to the hole center.

OK